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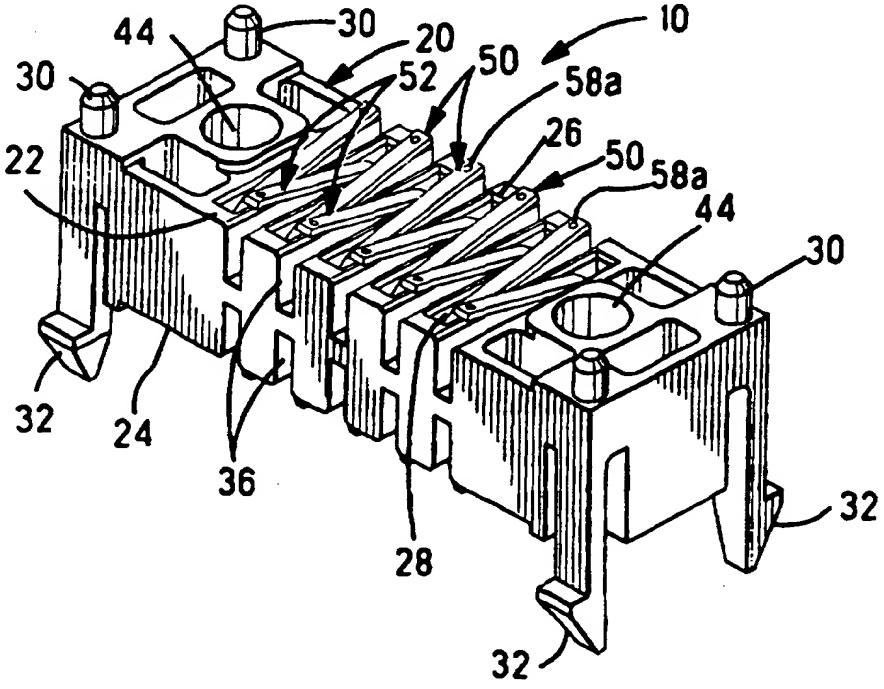
(57) Abstract

An electrical connector comprises an insulating housing (20) having surfaces (22, 24) for facing mutually facing circuit boards, electrical contacts (50, 52) disposed in contact press-fitting holes (26, 28) in the insulating housing (20) with central sections of the contacts secured within the insulating housing (20), and contact sections of the electrical contacts (50, 52) extending outwardly from the surfaces (22, 24) of the insulating housing (20) which are bent to extend along the respective surfaces (22, 24) and spaced therefrom defining spring contact members (54, 58) for electrical engagement with conductive pads on the circuit boards.



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ELECTRICAL CONNECTOR AND METHOD FOR MANUFACTURING THE SAME

The present invention relates to an electrical connector for disposition between mutually facing circuit boards so that the circuit boards are electrically connected to each other.

Electrical connectors which electrically connect mutually facing circuit boards have been widely used in the past. An electrical connector of this type is disclosed in Japanese Patent Publication No. 55-37787 in which through-holes are formed inside an insulating housing, and contacts which are bent in a multiple number of places in order to endow the contacts with spring properties, are passed through the through-holes in the insulating housing and fastened in place. Another connector of this type is disclosed in Japanese Patent Publication No. 63-43279 in which contact retaining ribs are formed inside an insulating housing, and contacts with spring properties are retained therein by these ribs.

The contacts used in the conventional electrical connectors described above are formed by punching metal plates into predetermined shapes prior to the installation of the contacts in the insulating housing. These contacts have complicated shapes in order to endow the contacts with spring properties; accordingly, the work involved in manufacturing the contacts and the work required in order to install the manufactured contacts within the insulating housing are also complicated. As a result, the manufacturing process used to manufacture such electrical connectors is relatively complicated. Furthermore, in the manufacture of the contacts, the portions of the punched metal plates that do not form portions of the contacts are discarded. As a result, the utilization of materials is inefficient, and a corresponding increase in the cost takes place. In addition, the positions of engagement between the

contacts and the circuit boards may be skewed, so that the orientation of the electrical connector mounted on the circuit boards is not correct, thus leading to the electrical connector providing improper connections between the contacts and the conductive pads on the circuit boards.

The present invention was devised to overcome the above drawbacks. One feature of the present invention is to provide an electrical connector which utilizes contact materials in an efficient manner, and which maintains a stable attitude when mounted on circuit boards. Furthermore, another feature of the present invention is to provide a method for manufacturing an electrical connector in which the manufacturing process is simpler than in conventional methods.

The electrical connector of the present invention is to be disposed between mutually facing circuit boards so that the circuit boards are electrically connected to each other, the electrical connector comprises an insulating housing which has two surfaces that face the respective circuit boards, and in which a plurality of contact press-fitting holes that pass through the two surfaces are formed in a row; and a plurality of plate contacts, each including a central section that is press-fit into one of the contact press-fitting holes, and two contact sections that extend from the central section and springably engage the respective circuit boards, the contacts being aligned in a row in the insulating housing.

Furthermore, the method of the present invention for manufacturing the electrical connector of the present invention which is to be disposed between mutually facing circuit boards so that the circuit boards are electrically connected to each other, comprises molding an insulating housing having surfaces for facing respective circuit boards and a row of contact press-fitting holes that extend through the

surfaces; forming linear contacts each of which includes a central section and contact sections extending outwardly from the central section; inserting the linear contacts into the contact press-fitting holes so that the central sections are press-fitted within a press-fitting section of the insulating housing and the contact sections extend outwardly from the surfaces of the insulating housing; and bending the contact sections so that they extend along the surfaces of the insulating housing as spring contact members for springable engagement with the circuit boards to electrically connect the circuit boards together.

An embodiment of the invention will now be disclosed by way of example with reference to the accompanying drawings in which:

FIGURE 1 is an isometric view of an electrical connector of the present invention;

FIGURE 2 is a top plan view of FIG. 1;

FIGURES 3 and 4 are side elevational and end views respectively of FIG. 2;

FIGURES 5 and 6 are cross-sectional views taken along lines 5-5 and 6-6 respectively of FIG. 3;

FIGURE 7 is a top plan view of the insulating housing of the electrical connector shown in FIG. 1;

FIGURES 8 and 9 are side elevational and end views respectively of FIG. 7;

FIGURE 9 is an end view of FIG. 7;

FIGURE 10 is an enlarged view of one of a contact press-fitting holes in the insulating housing;

FIGURES 11 and 12 are cross-sectional views taken along lines 11-11 and 12-12 respectively of FIG. 7;

FIGURE 13 is a top plan view of an electrical contact for insertion into a contact press-fitting hole of the insulating housing;

FIGURE 14 is a side view of FIG. 13;

FIGURE 15 is a part cross-sectional view showing a contact section in electrical engagement with a circuit pad of a circuit board; and

FIGURE 16 is a view similar to FIG. 15 showing the contact section soldered to the circuit pad.

Electrical connector 10 of the present invention comprises an insulating housing 20 which has an upper surface 22 and a lower surface 24 that face circuit boards (not shown), and a plurality of electrical contacts 50 and 52 which are installed in rows in the insulating housing 20.

Contact press-fitting holes 26 and 28 which pass through the upper surface 22 and lower surface 24 are formed in respective single rows in the insulating housing 20 along respective sides thereof, so that the contact press-fitting holes 26 and 28 form a desired pattern as seen in an overall view. Contacts 52 are press-fitted in the contact press-fitting holes 26, and contacts 50 are press-fitted in the contact press-fitting holes 28. The central sections of the respective contacts 50 and 52 are secured in the contact press-fitting holes 28 and 26. Furthermore, cavities 36 and 38, which communicate with the respective contact press-fitting holes 26 and 28, are formed in the insulating housing 20. These cavities 36 and 38 are provided in order to insure a sufficient bending space for the bending of both end sections of the contacts 50, 52 projecting linearly from the contact press-fitting holes 26 and 28 as described later. When both end sections of the contacts 50, 52 are subjected to bending in order to form spring contact members 54 and 58, the end sections are bent as far as the interiors of the cavities 36 and 38, so that compensation is made for the return of the end sections due to "spring-back". Engaging members 40 and 42, which act as bending fulcrums for the bending of the end sections of the contacts 50, 52, are formed in the boundary areas

between the contact press-fitting holes 26 and 28 and the cavities 36 and 38. As shown in FIG. 3, these engaging members 40 and 42 also provide support when the contact sections 54 and 58 engage the circuit boards and bend.

Furthermore, positioning bosses 30, which are used to position the electrical connector 10 on one of the circuit boards, are formed at the four corners of the upper surface 22 of the insulating housing 20. Moreover, flexible fastening legs 32, which are used for the temporary fastening of the electrical connector 10 to the other circuit board, are formed at the four corners of the lower surface 24. The heights of the bosses 30 and legs 32 are higher than the heights of the contact members 54 and 58 extending along the upper and lower surfaces 22 and 24 of the insulating housing 20. Accordingly, the bosses 30 and legs 32 also act to protect the contact members 54 and 58. Furthermore, it would also be possible to form positioning bosses similar to the positioning bosses 30 instead of the legs 32. Moreover, through-holes 44 used for bolt fastening are formed through the upper surface 22 and lower surface 24, and bolts (not shown) are passed through these through-holes 44 thereby bolt fastening the electrical connector 10 to the circuit boards.

Next, the contacts and the interior shapes of the contact press-fitting holes will be described.

The contacts 50 and 52 have the same shape; accordingly, only contacts 50 will be described. As shown in FIGS. 13 and 14, the shape of the contacts 50 at the time of press-fitting in the contact press-fitting holes 26 is linear. Contacts with the shape described above can be manufactured by bending both end sections of these linear contacts. These linear contacts can be manufactured by punching the contacts out of a metal plate. Accordingly, since the waste

portions of the metal plate are reduced in size, the utilization of material is very efficient.

Contact projections 58a and 58b, which engage conductive pads on the circuit boards, are formed on the respective end sections of the contacts 50. Furthermore, two projections 60 and 62 are formed on the central section of each contact 50. The height of the contact projections 58a and 58b is approximately 0.08 mm, the height of the projections 60 is approximately 0.52 mm, and the height of the projections 62 is approximately 0.55 mm. As shown in FIG. 10, the cross-sectional shape of the contact press-fitting holes 26 in which the contacts 50 on which the above projections are formed are press-fitted is a T-shaped cross section which has projecting space 26a formed in the central portion. When the contacts 50 are press-fitted in the contact press-fitting holes 26, the contacts 50 are inserted into the contact press-fitting holes 26 from the end of the contact projections 58a. When each contact 50 is press-fitted in the corresponding contact press-fitting hole 26, the contact projection 58a faces in the opposite direction from the projecting space 26a, so that the contact projection 58a passes smoothly through the contact press-fitting hole 26. The projection 60 enters the contact press-fitting hole 26 first, after which the projection 62 enters the contact press-fitting hole 26. The projection 60 proceeds smoothly through the contact press-fitting hole 26; however, since the height of the projection 62 is greater than the height of the projection 60, the projection 62 frictionally engages the walls of the insulating housing 20 at a point slightly to the inside of the entrance of the contact press-fitting hole 26. As a result of this frictional engagement, the contact 50 stops. In this case, anchoring projections 64 formed on the contact 50 bite with the walls of contact press-fitting hole 26 in the insulating housing 20; as a

result, the contact 50 is fastened in place in the contact press-fitting hole 26.

The contacts 50 fastened in place in the contract press-fitting holes 28 as described above, are linear in form. Then, both end sections of each contact 50 are subjected to bending with the engaging members 42 operating as supporting points, so that contact members 58, which extend along the upper and lower surfaces 22 and 24 from both ends of the central section having the projections 60 and 62, to springably engage the circuit boards, are formed. The same operation is carried out for contacts 52 when they are fastened within contact press-fitting holes 26. As shown in FIGS. 13 and 14, respective contact projections 58a and 58b are formed on these contact members 54 and 58; the contacts 50 and 52 are arranged in alternate opposing directions, these contact projections 58a and 58b are also arranged in like manner. When the electrical connector 10 is mounted on the circuit boards, the contact projections 58a and 58b thus arranged electrically engage conductive pads on the circuit boards so that the force acting between the circuit boards and the electrical connector 10 is balanced, thereby causing the electrical connector 10 to be maintained in a stable attitude and orientation. Furthermore, since contact members are formed on the contacts 50 by press-fitting the linear contacts 50 in contact press-fitting holes 28 and subjecting the contacts 50 to bending as described above, manufacture of the electrical connector is simple.

Next, the effect of the contact members will be described with reference to FIG. 15 and 16. Here, the contact projections 58a on the contact 50 will be described as an example.

In cases where conductive pads 72 are formed on the circuit boards 70 as shown in FIG. 15, the contact projections 58a wipingly engage these conductive pads 72

with a high contact pressure; accordingly, a high electrical connection reliability is obtained. On the other hand, in cases where conductive pads 72 have flow solder or the like 76 thereon located on the circuit boards 70 as shown in FIG. 16, the areas surrounding the contact projections 58a on the contacts 50 engage the solder 76, so that the contact projections 58a do not sink into the solder 76 any further than is necessary. Accordingly, as in the case of FIG. 15, a high electrical connection reliability is obtained.

In the electrical connector of the present invention, as was described above, contacts are press-fitted in a plurality of contact press-fitting holes which are arranged in rows of an insulating housing. Accordingly, the force acting between the electrical connector and the circuit boards on which the electrical connector is mounted is balanced, so that the electrical connector is maintained in a stable attitude and orientation. Furthermore, since each of the contacts comprises a central section and contact sections which extend from the central section, contacts with this shape can be manufactured by press-fitting linear contacts in the contact press-fitting holes, and then bending the end sections of the contacts. Such linear contacts can be manufactured by punching a metal plate; accordingly, the discarded portions of the metal plate are small, so that the utilization of material is very good and economical.

Furthermore, in the method according to the present invention for manufacturing an electrical connector, an insulating housing is molded with press-fitting holes, linear contacts are formed, and these linear contacts are press-fitted in the contact press-fitting holes in the insulating housing, after which both end sections of the linear contacts are bent so that spring contact sections extend along opposed surfaces of the insulating housing. Accordingly, there is no need to manufacture

contacts which have a complicated shape, and the electrical connector manufacturing process is therefore simplified.

IN THE CLAIMS:

The invention is claimed according to the following:

1. An electrical connector for disposition between mutually facing circuit boards and for electrical connection with conductive pads on the circuit boards comprises an insulting housing (20) having surfaces (22, 24) for facing the respective circuit boards and holes (26, 28), electrical contacts (50, 52) disposed in the holes (26, 28) including contact members (54, 58) characterized by:

said holes (26, 28) are contact press-fitting holes in which the electrical contacts (50, 52) in linear form are inserted with central sections of the contacts secured inside the insulating housing and contact sections extend from the central sections beyond the respective surfaces (22, 24) of the insulating housing, said contact sections being bent to extend along the respective surfaces and spaced therefrom defining spring contact members (54, 58) for electrical engagement with the conductive pads on the circuit boards.

2. An electrical connector as claimed in claim 1, wherein said contact press-fitting holes (26, 28) extend in rows along respective sides of said insulating housing.

3. An electrical connector as claimed in claim 2, wherein the contact press-fitting holes (26) along one side of the insulating housing (26) are offset with respect to the contact press-fitting holes (28) along the other side of the insulating housing (20).

4. An electrical connector as claimed in claim 3, wherein the spring contact members (58) of electrical contacts (50) extend along surfaces (22, 24) in one direction whereas the spring contact members (54) of electrical contacts (52) extend along surfaces (22, 24) in an opposite direction from said one direction.

5. An electrical connector as claimed in claim 1, wherein engaging members (40, 42) are provided in said insulating housing (20) which define fulcrums against which the contact sections engage for bending the contact sections so that they extend along the surfaces (22, 24) as spring contact members (54, 58).

6. An electrical connector as claimed in claim 1, wherein positioning bosses (30) and flexible legs (32) are provided on insulating housing (20) for positioning the connector on the circuit boards.

7. A method for manufacturing an electrical connector to be disposed between mutually facing circuit boards to electrically connect the circuit boards together comprising an insulating housing (20) having surfaces (22, 24) for facing the respective circuit boards and electrical contacts (50, 52) secured in the insulating housing (20) having spring contact members (54, 58) for electrical engagement with conductive pads on the circuit boards, characterized by the steps of:

molding the insulating housing (20) with at least one row of contact press-fitting holes (26, 28) that extend through the surfaces (22, 24) of the insulating housing (20);

forming linear contacts (50, 52) each of which includes a central section and contact sections extending outwardly from the central section;

inserting the linear contacts (50, 52) into the contact press-fitting holes (26, 28) so that the central sections are press fitted within a press-fitting section of the insulating housing and the contact sections extend outwardly from the surfaces (22, 24) of the insulating housing (20); and

bending the contact sections so that they extend along the surfaces (22, 24) as spring contact members (54, 58) for springable electrical engagement with the conductive pads on the circuit boards to electrically connect the circuit boards together.

8. A method as claimed in Claim 7, wherein another row of press-fitting holes (26, 28) is formed in the insulating housing (20) so that the contact sections extending outwardly from the one row of contact press-fitting holes (26) are bent along the surfaces (22, 24) in one direction and the contact sections extending outwardly from the other row of contact press-fitting holes (28) are bent along the surfaces (22, 24) in a direction opposite to the one direction.

9. A method as claimed in claims 7 or 8, wherein engaging sections (40, 42) are provided in said insulating housing adjacent said contact press-fitting holes (26, 28) which define fulcrums against which the contact sections are bent.

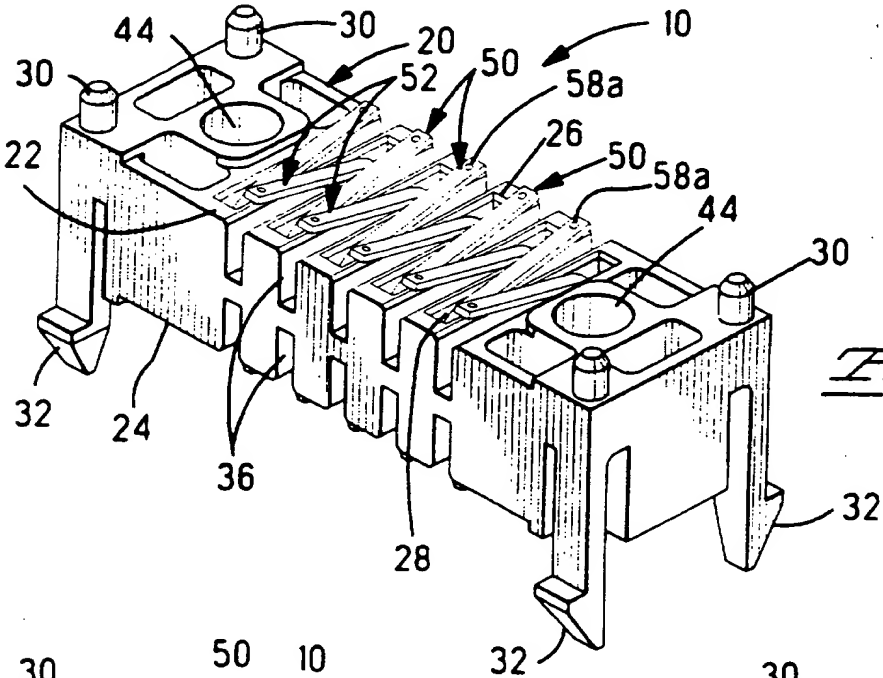

Fig. 1

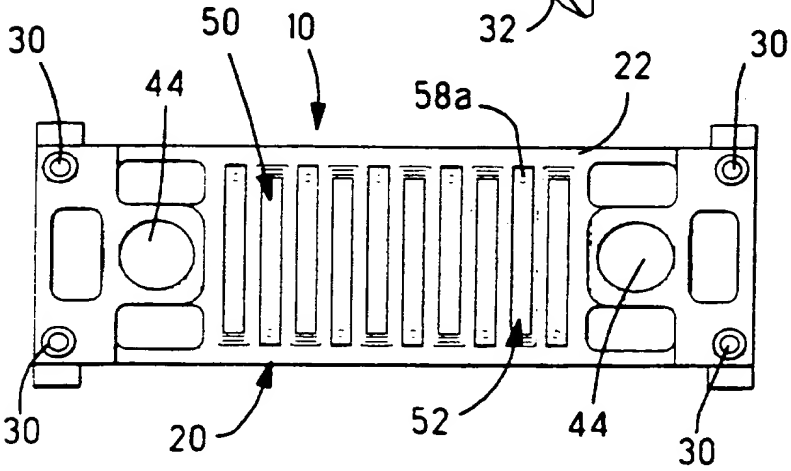

Fig. 2

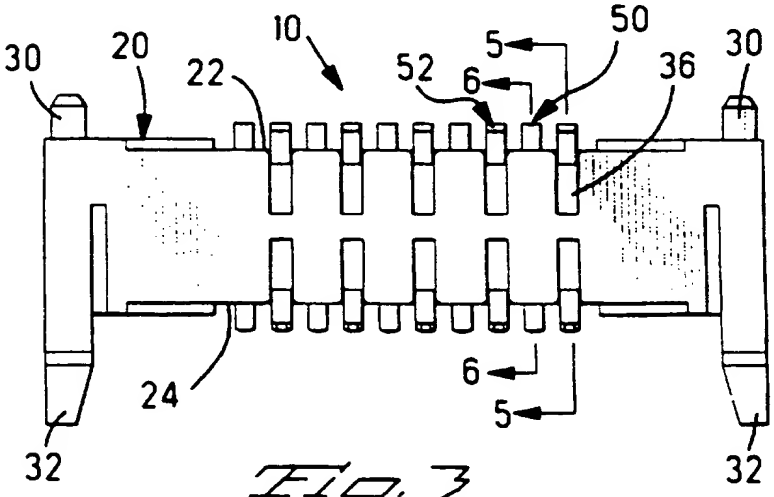

Fig. 3

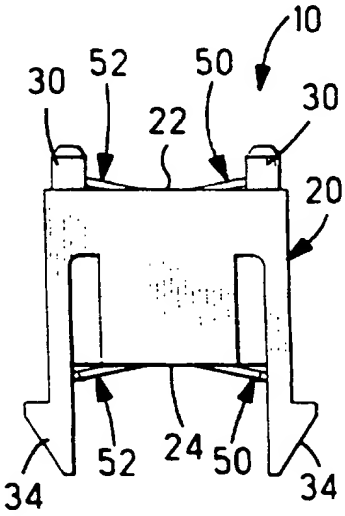

Fig. 4

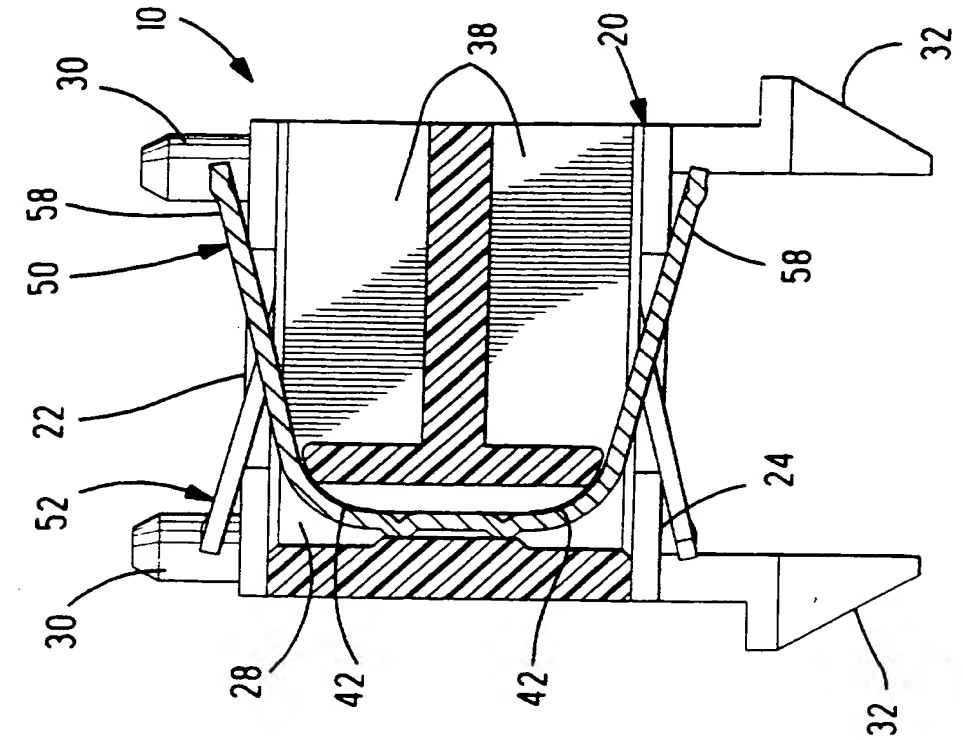

Fig. 6

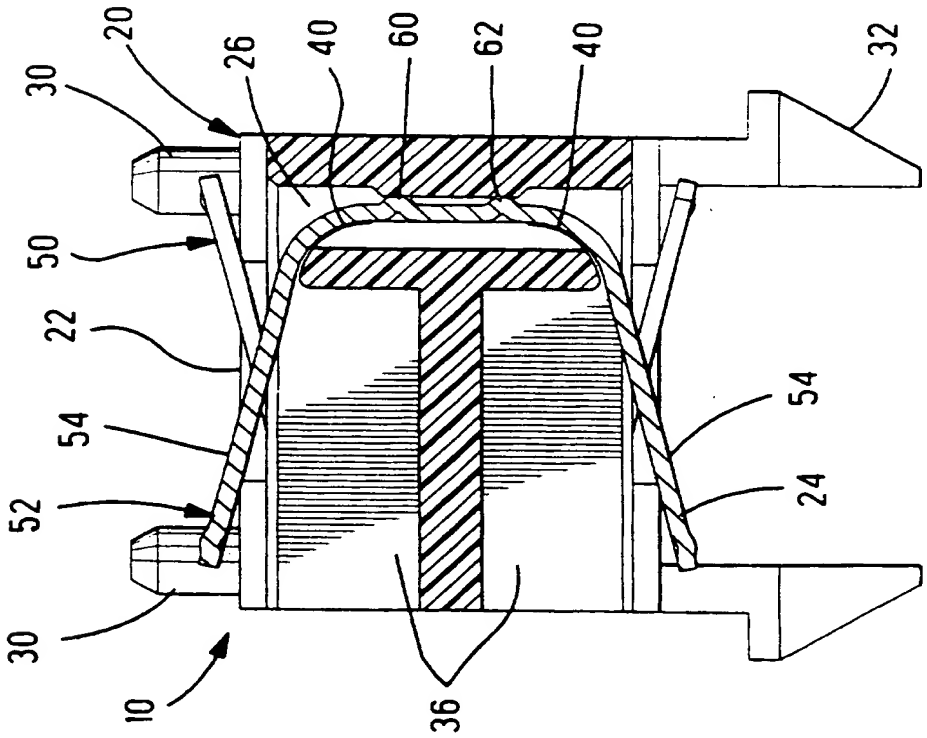

Fig. 5

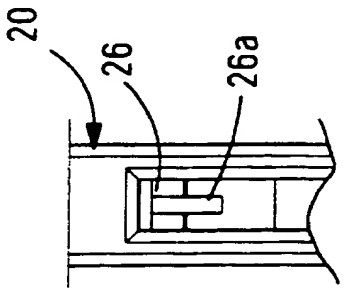

Fig. 10

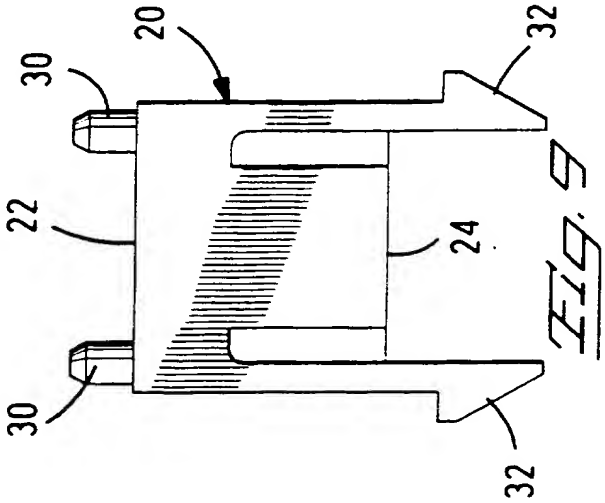

Fig. 9

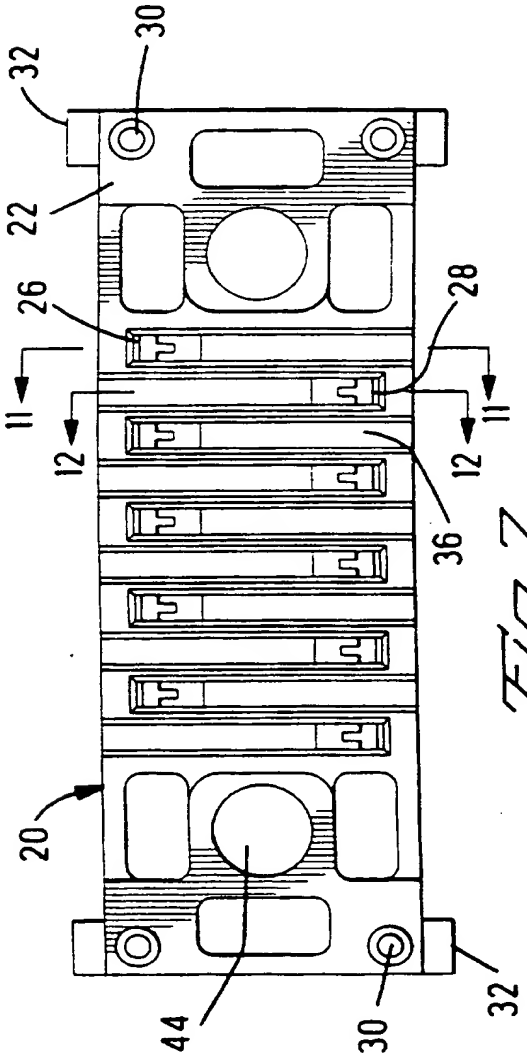

Fig. 7

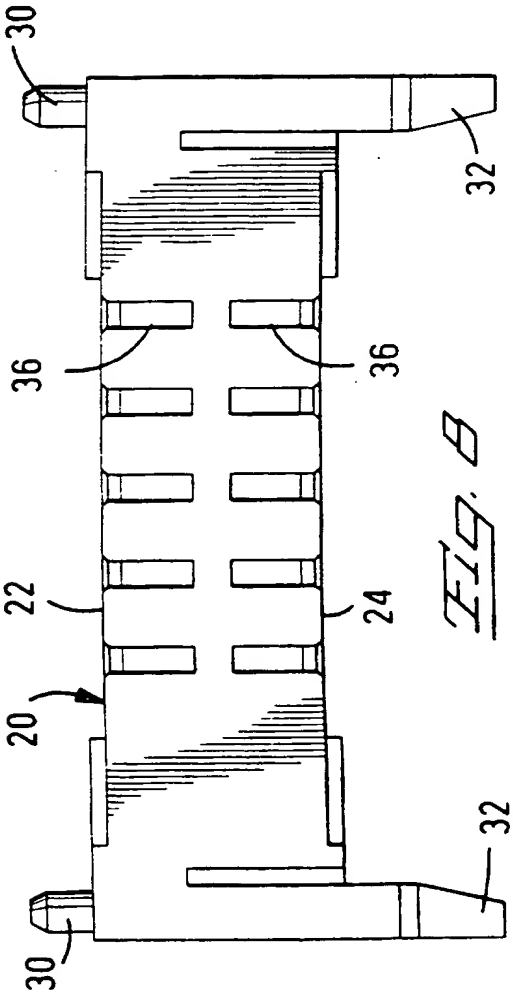

Fig. 8

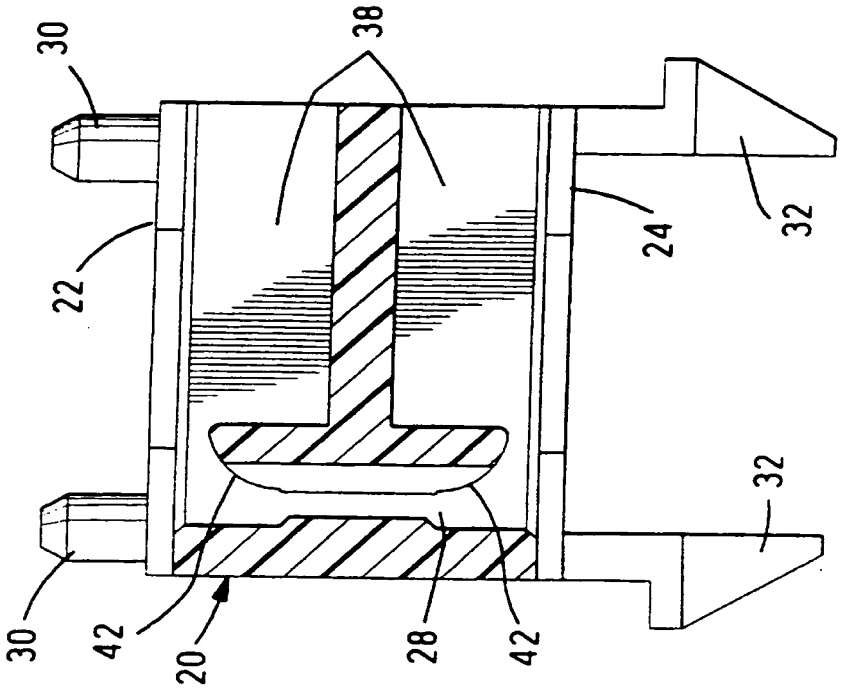

Fig. 12

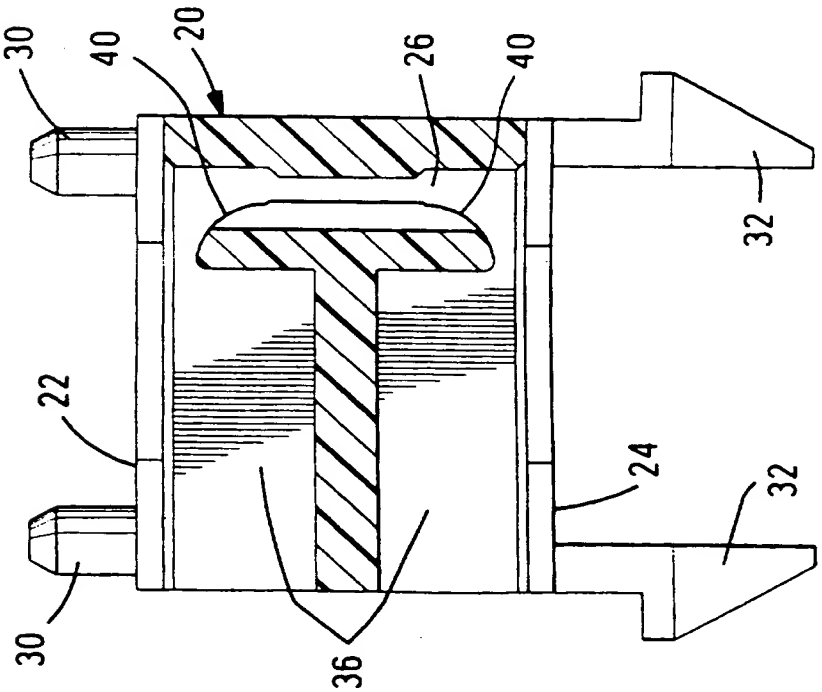

Fig. 11

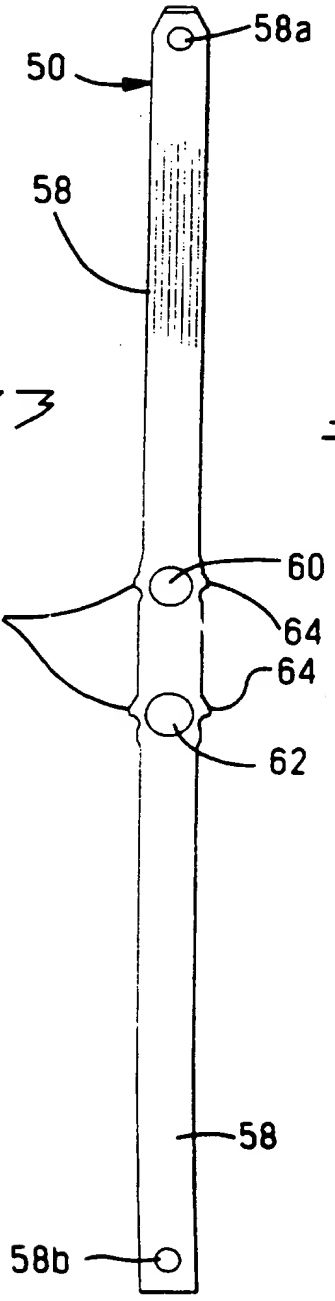

Fig. 13

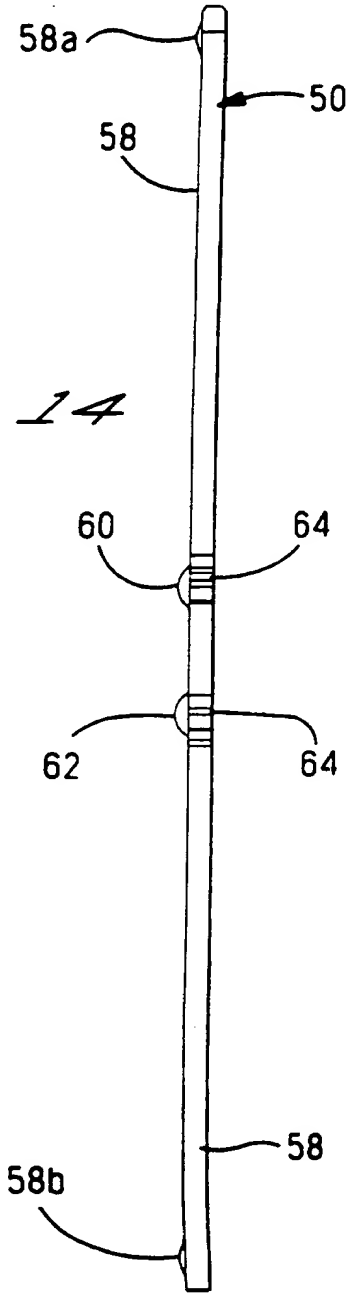

Fig. 14

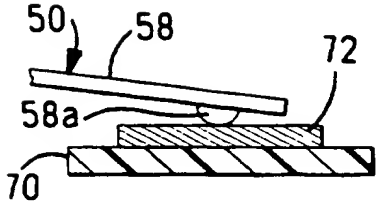

Fig. 15

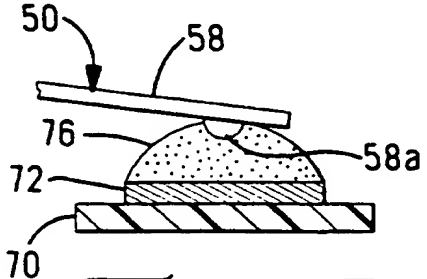

Fig. 16

INTERNATIONAL SEARCH REPORT

[illegible] al Application No
PCT/US 96/15004

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01R13/24 H01R9/09 H01R23/72

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE,A,14 90 440 (SIEMENS AG) 13 November 1969 ---	
A	US,A,5 380 210 (GRABBE DIMITRY ET AL) 10 January 1995 ---	
A	DE,A,22 34 961 (TELEDYNE INC) 12 April 1973 ---	
A	US,A,4 688 864 (SOREL ALAIN) 25 August 1987 ---	
A	US,A,3 960 424 (WEISENBURGER LAWRENCE PAUL) 1 June 1976 -----	

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 December 1996	- 8. 01. 97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (- 31-70) 340-2040, Tx. 31 651 epo nl, Fax (- 31-70) 340-3016	Authorized officer Horak, A

Form PCT/ISA 210 (second sheet) (July 1992)

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